

Other Biological Studies

Confirmed Presence of Neurotoxin-Producing Diatom Around Galveston, Texas

G.A. Fryxell, M.E. Reap, D.L. Roelke, L.A. Cifuentes, and D.L. Valencic
Department of Oceanography, Texas A&M University

Large populations of the pennate diatom, *Nitzschia pungens* Grunow, have been found around the coast of Prince Edward Island (P.E.I.), Canada's smallest Maritime Province, in the Gulf of St. Lawrence, and now its presence has been established around Galveston Island. The diatom has appeared seasonally (late summer, autumn, early winter) around P.E.I. since 1987; we have determined it to be a year-round resident of Galveston. A morphological form, and possibly a different species, *N. pungens f. multiseriis*, has been found to produce the powerful neurotoxin domoic acid that is responsible for the symptoms now called Amnesiac Shellfish Poisoning (ASP). In 1987-1988, ASP shocked Canadians and resulted in at least four deaths, permanent loss of immediate recall by 24 people, and over 107 digestive upsets when the victims consumed the diatom concentrated in the filter-feeding blue mussels (*Mytilus edulis* L.) commercially grown in mariculture projects of Prince Edward Island. This year for the first time in four years none of the fisheries had to be closed, although trace amounts of domoic acid were found.

The story of these events provides an excellent model of how the mariculture industry, universities (e.g., University of Prince Edward Island, Charlottetown, P.E.I.; Bedford Institute of Oceanography [B.I.O.], Dartmouth, N.S.), and governmental agencies (e.g., Division of Fisheries and Oceans [D.F.O.], Moncton, N.B., Institute for Marine Biosciences [I.M.B.], Halifax, N.S.), have worked together effectively to protect the health of the public, as well the area's multi-million dollar mariculture industry. This model has more than academic interest for those of us concerned with Galveston Bay or with the seven other inshore areas around the world where the presence of *N. pungens f. multiseriis* has now been confirmed.

Nitzschia pungens f. multiseriis was first identified from Galveston as the dominant diatom from a collection by a TAMU graduate oceanography class 25 February 1989 at the 61st Street fishing pier at the inner end of Offatt's Bayou. There was no discoloration of the water since cell numbers were small. It was also present when the next collection was made 24 May 1989. An archived collection from East Lagoon from 19 January 1974 shows it to be abundant in that collection, as well. So it has not been introduced recently and is well adapted to survival in our coastal areas. Under some growing conditions, such as the high nitrates from cultivated fields (as in P.E.I.), it can dominate. Systematic collections were undertaken beginning in May, 1989, with the aim of getting the organism in culture and testing its toxicity in the warmer waters of the Gulf of Mexico. It was not known if the diatom had the genetic code for producing domoic acid, or if it was host to a bacterial symbiont, perhaps, that produced the toxin. By growing our own clones to bloom proportions, we could test how similar our genetic stock was to the few in culture in Canada.

Like many bloom species, *Nitzschia pungens* proved difficult to grow in the laboratory. After the first successful isolation was made by T.K. Ashworth, however, methods were streamlined for collection, isolation, and culture maintenance of both *Nitzschia pungens* f. *multiseries* and the closely related *Nitzschia pungens* f. *pungens*. With the cooperation and encouragement of Canadian scientists (e.g., A.S.W. deFreitas, C.J. Bird, J.L.C. Wright, and M.A. Quilliam [I.M.B.]; J.C. Smith and S.S. Bates [D.F.O.]; and R. Pocklington [B.I.O.]), the three first-year Texas isolates proved not only to be toxic, but to produce toxins at the top of the range known from Canada. These clones have been toxic in culture only when they reached stationary or senescent growth phases and their growth limited. We must field-test these findings in Galveston Bay and other coastal areas on the Gulf of Mexico.

Over the last 18 months in the Department of Oceanography, TAMU, we have had 21 clones of *Nitzschia pungens* f. *multiseries*, isolated mostly from January to June, and 31 clones of the apparently non-toxic *Nitzschia pungens* f. *pungens*, isolated from the warmer months, June to December. We have recently performed pilot tests of the production of domoic acid on the first of our second-year clones, using high performance liquid chromatography (HPLC). They are also toxic. It should be remembered that cultures and/or field samples principally from two areas in the world, Gulf of Mexico and Gulf of St. Lawrence, have been proved by HPLC to produce the neurotoxin, domoic acid.

But thus far, *all* tested clones with the morphology of *N. pungens* f. *multiseries* are domoic acid producers in stationary growth phase. At this point our assumption is that all populations of *Nitzschia pungens* f. *multiseries* can become toxic in senescent blooms. Since it has been firmly identified on the east coasts of North and South America (now including the Gulf of Mexico), the west Coast of North America, Korea, and Oslofjord, the onset of problems in the nutrient-rich P.E.I. estuaries serves as a warning. With increasing phosphates and nitrates in coastal, eutrophic waters, the seed stock could proliferate. Now is the time to set in motion the mechanisms to protect the public and the fishery.

Work is in progress to analyze our field and laboratory results and to compare them with published results from Canadian blooms. We need not only more laboratory work with our clones, but also nutrient and circulation models of Galveston Bay. Proposals are in preparation for studies to assess the risk of winter blooms in our Gulf of Mexico estuaries (where a winter bloom would not be limited by ice-cover as it is around Prince Edward Island) and the possibility of concentrations of toxin in our filter-feeding estuarine oysters. We welcome cooperation with others. By learning from the tragic experience in Canada and their ensuing successful management program, we can avoid similar disasters in our own highly productive coastal areas.

Sea Turtle Head Starting and Ecology Research

Charles W. Caillouet, Jr., Sharon A. Manzella, Gregg R. Gitschlag,
Maurice L. Renaud, and Edward F. Klima
National Marine Fisheries Service

The distribution, migration patterns, habitat preference, and behavior of sea turtles in Galveston Bay and other Texas waters are poorly understood. Such life history information is obtained from a number of sea turtle research projects at the National Marine Fisheries Service (NMFS) Galveston Laboratory. These projects provide information essential to evaluation of human impacts on sea turtles. Five species of sea turtle occur in Texas: Kemp's ridley (*Lepidochelys kempii*), loggerhead (*Caretta caretta*), green (*Chelonia mydas*), hawksbill (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*).

Multi-year data bases of sea turtle tag-recaptures, sea turtle strandings, sea turtle by-catch and sea turtle sightings are maintained for head-started Kemp's ridleys and wild sea turtles to determine their distribution, movements, and habitats. Cooperation in maintaining these data bases is obtained from federal and state agencies, the Offshore Operator's Committee, the petroleum industry, diver's organizations, fishermen, fishing guides, and the general public.

Little is known about the behavior and habitat selection of sea turtles in Texas waters. Turtle movements, habitat selection, behavior (time at surface and time submerged), and associated environmental variables (water depths, temperature and salinity) are determined with satellite, radio and sonic tracking. Examination of carcasses of stranded sea turtles provides information on food habits, sex, size, maturity, and reproductive stage. Such life history information may be used to determine critical habitats for endangered and threatened sea turtles as well as impacts of human activities on sea turtles.

Satellite, radio and sonic tracking are used to collect life history information on sea turtles in estuarine and offshore waters. Turtle movements, habitat selection, behavior (time at surface and time submerged) and associated environmental variables (water depth, temperature, and salinity) are recorded. In addition, inshore distributions are being examined to document occurrence of sea turtles in relation to dredge and fill operations.

The Galveston Laboratory also assesses impacts of petroleum structure removals using explosives. The frequency and abundance of sea turtles and marine mammals around production platforms and related structures, and their incidental take, are documented during such removals. NMFS observers monitor the waters around the removal site prior to, during and after the detonation of explosive charges. Aerial surveys using helicopters are required if so stated in the Section Seven consultation under the Endangered Species Act. Detonations are restricted to periods of daylight when visibility is adequate for monitoring the site for protected species. Pre-blast surveys also are conducted by divers who note the presence of sea turtles, marine mammals and fish around the site. Following the detonation of charges, floating animals are recovered from a boat, while divers sample the ocean floor for dead animals.

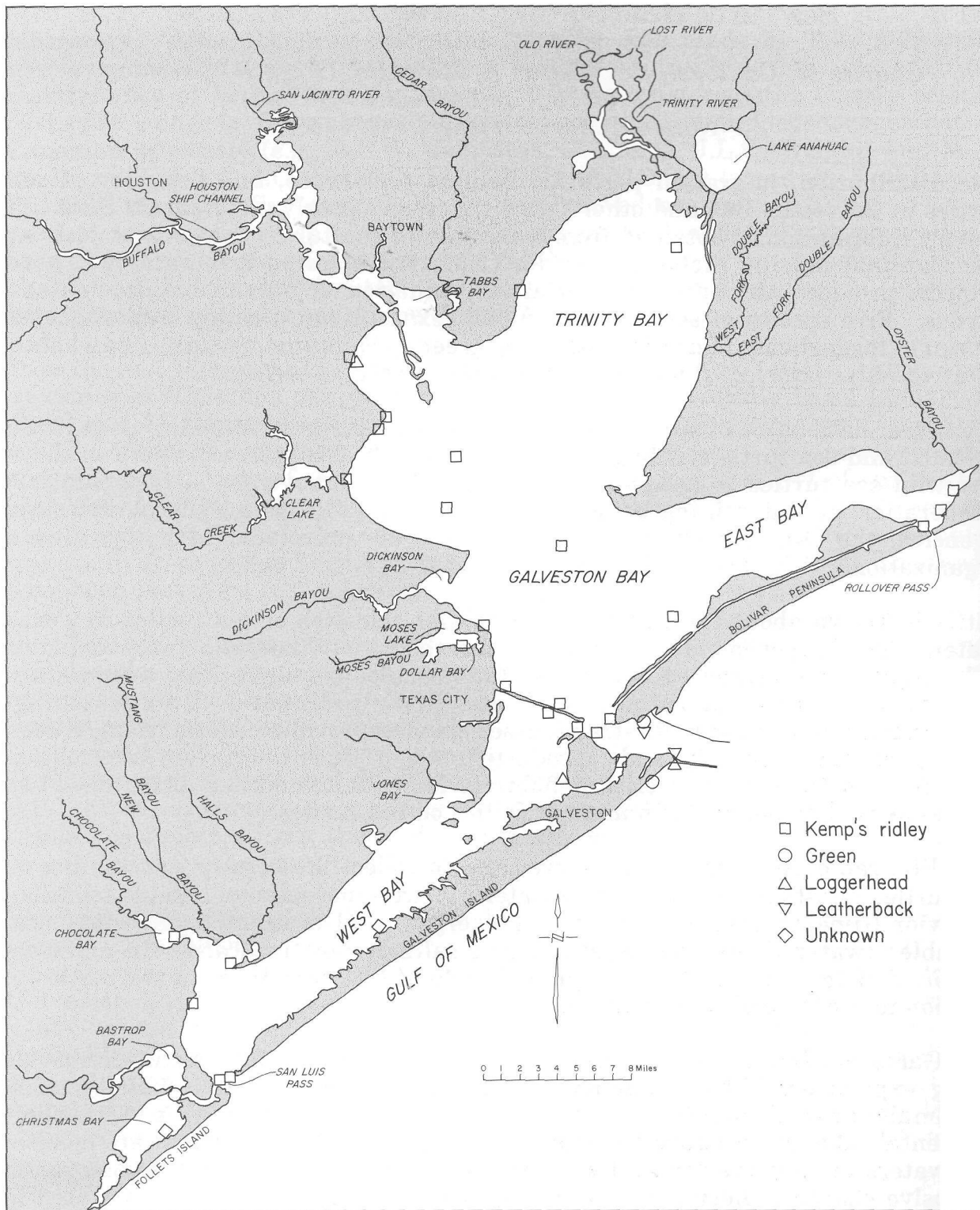


Figure 1. Sea turtle distribution in Galveston Bay, 1980-1991.

Table 1. Sea turtle records from Galveston Bay, 1980-1991, by species.

	Wild	Head Started
Kemp's ridley	16	10
Green	4	
Loggerhead	3	
Leatherback	2	
Unknown	2	
Total	27	10

Table 2. Sources of data for sea turtle records from Galveston Bay, 1980-1991.

	Wild	Head Started
Stranded dead	18	3
Shrimp trawl	3	4
Sighting	3	0
Hook and line	1	0
Swimming	0	1
Stranded live	1	0
Not reported	1	2
Total	27	10

Table 3. Seasonal distribution for sea turtle records from Galveston Bay, 1980-1991.

	Wild	Head Started
Jan. - Mar.	0	0
Apr. - June	12	6
Jul. - Sept.	10	3
Oct. - Dec.	5	1
Total	27	10

Table 4. Carapace lengths by species for sea turtles from Galveston Bay, 1980-1991.

	Wild	Head Started
Kemp's ridley	30-60	30-50
Green	29-35	
Loggerhead	34-65	
Leatherback	156	

The Galveston Laboratory conducts evaluations of turtle excluder devices (also trawling evaluations of turtle excluder devices or TEDs), using NMFS observers on commercial shrimp boats. These evaluations determine the catch rates for shrimp, bycatch species and sea turtles in standard trawls in comparison to TED-equipped trawls.

Additional research on sea turtles in Texas is essential for development of conservation and management strategies to prevent their extinction.

Responses of Postlarval Penaeid Shrimp to Galveston Bay Olfactants

Mark C. Benfield

Department of Wildlife & Fisheries Sciences, Texas A&M University
and

David V. Aldrich

Texas A&M University at Galveston

Penaeid shrimp are key components in the diets of commercially and ecologically important finfish species in Galveston Bay. Brown shrimp (*Penaeus aztecus*) and white shrimp (*Penaeus setiferus*) also support valuable inshore bait and offshore commercial fisheries. The life cycles of both species include a period of estuarine dependency. Following offshore spawning and hatching, shrimp pass through a series of larval stages while they are carried toward the coast. Shrimp enter estuaries as postlarvae where they inhabit salt marsh and seagrass habitats. Shrimp exploit the abundant food resources and favorable growth conditions within these habitats and generally migrate offshore after several months to complete maturation and spawn. The extensive salt marshes within Galveston Bay form a vitally important nursery habitat for penaeid shrimp along the Texas coast.

Little is known about the mechanisms by which postlarval shrimp identify and gain access to estuaries. Current recruitment theory suggests that postlarvae orient towards the horizontal salinity gradients which extend outwards from estuaries and gain access by exploiting tidal currents in response to tidal salinity differentials, pressure or endogenous activity rhythms. Virtually nothing is known about how shrimp locate nursery habitats once they have entered an estuary.

Several studies suggest that postlarval shrimp are attracted to the odor of estuarine water and that this response can override their attraction to low salinity. These observations have not received serious experimental evaluation. In this paper we describe results from an ongoing study to measure the attraction of postlarval brown and white shrimp to estuarine water from Galveston Bay and identify the sources of the attractant(s).

Experiments were conducted in a laminar-flow choice chamber which provides individual test animals with a free choice between two water types discretely separated without the use of physical barriers. Postlarvae were given a choice between test odors and odor-free synthetic seawater. Brown and white shrimp postlarvae from the surf zone of Galveston Island demonstrated significant attraction to water from a West Bay salt marsh. Experiments conducted near the end of the fall brown shrimp recruitment period suggested that water from Galveston Bay lost its attractiveness over winter when conditions in the marsh are generally unfavorable for shrimp growth and survival. The seasonal loss of attractiveness further suggested that the attractant(s) are biogenically produced. Rinses from representative salt marsh flora and fauna are being tested as potential sources of attractant. This paper contains preliminary results for smooth cordgrass *Spartina alterniflora*, *Spartina detritus* and epiphytic diatoms.

Most Galveston Bay salt marshes are dominated by *S. alterniflora*. Two factors made *Spartina* a logical candidate as an attractant source. These plants are known to produce leachates which are rich in organic compounds and undergo a winter productivity reduction. Replicate experiments with postlarval brown shrimp did not indicate any significant attraction to leachates from living *Spartina*.

Most of *Spartina*'s energy is transferred to the salt marsh food web via detrital decomposition. Penaeid shrimp are known to feed on the small invertebrates which colonize detritus. Studies with American eels suggested that rinses from detrital plant material were attractive to elvers during their landward migrations. Our experiments with postlarval brown shrimp failed to demonstrate any significant attraction to *Spartina* detrital leachates.

The shoots of *Spartina* are covered by thick growths of epiphytic algae. These epiphyte communities are dominated by diatoms which form an important initial food source for postlarval and early-juvenile penaeids. Algae are also known to produce organic leachates and the odor of these compounds might provide a good indication of habitat quality. Initial experiments suggest that postlarval brown shrimp are significantly attracted to the odor of epiphytes.

The heavy concentration of petrochemical industry around Galveston Bay results in substantial pollutant loadings. Other studies conducted on a variety of marine organisms suggest an ability to detect and avoid pollutants at low concentrations. It is possible that avoidance of pollutants might suppress attraction of postlarval penaeids to attractive estuarine odors. Our choice chamber permits exposure of postlarvae to dissolved pollutants with precise control of exposure concentrations. The final phase of our study will examine the responses of postlarval brown shrimp to representative Galveston Bay pollutants.

Our results suggest that in addition to their well documented nursery functions, salt marshes serve as the source of chemical signals which may assist postlarval shrimp in successfully locating Galveston Bay and its component nursery habitats. These observations further emphasize the need for protection of the salt marsh habitats in Galveston Bay.